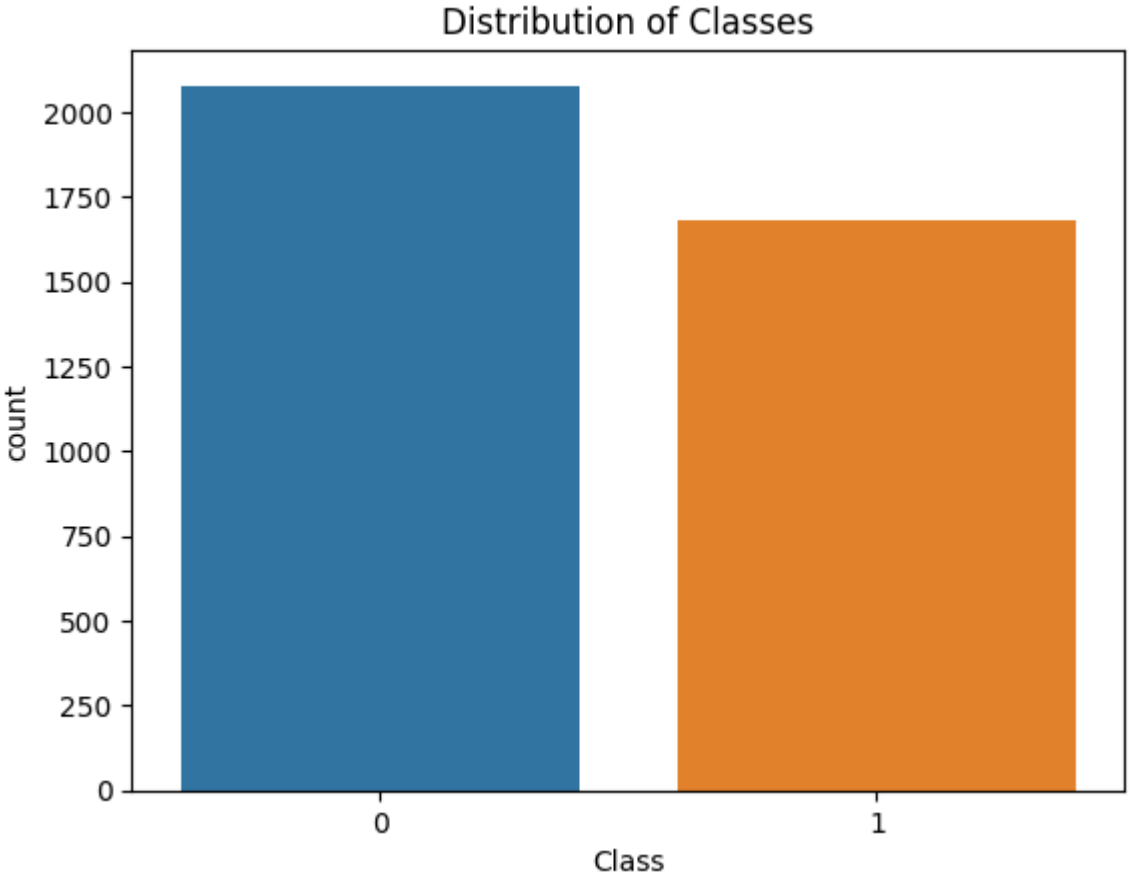
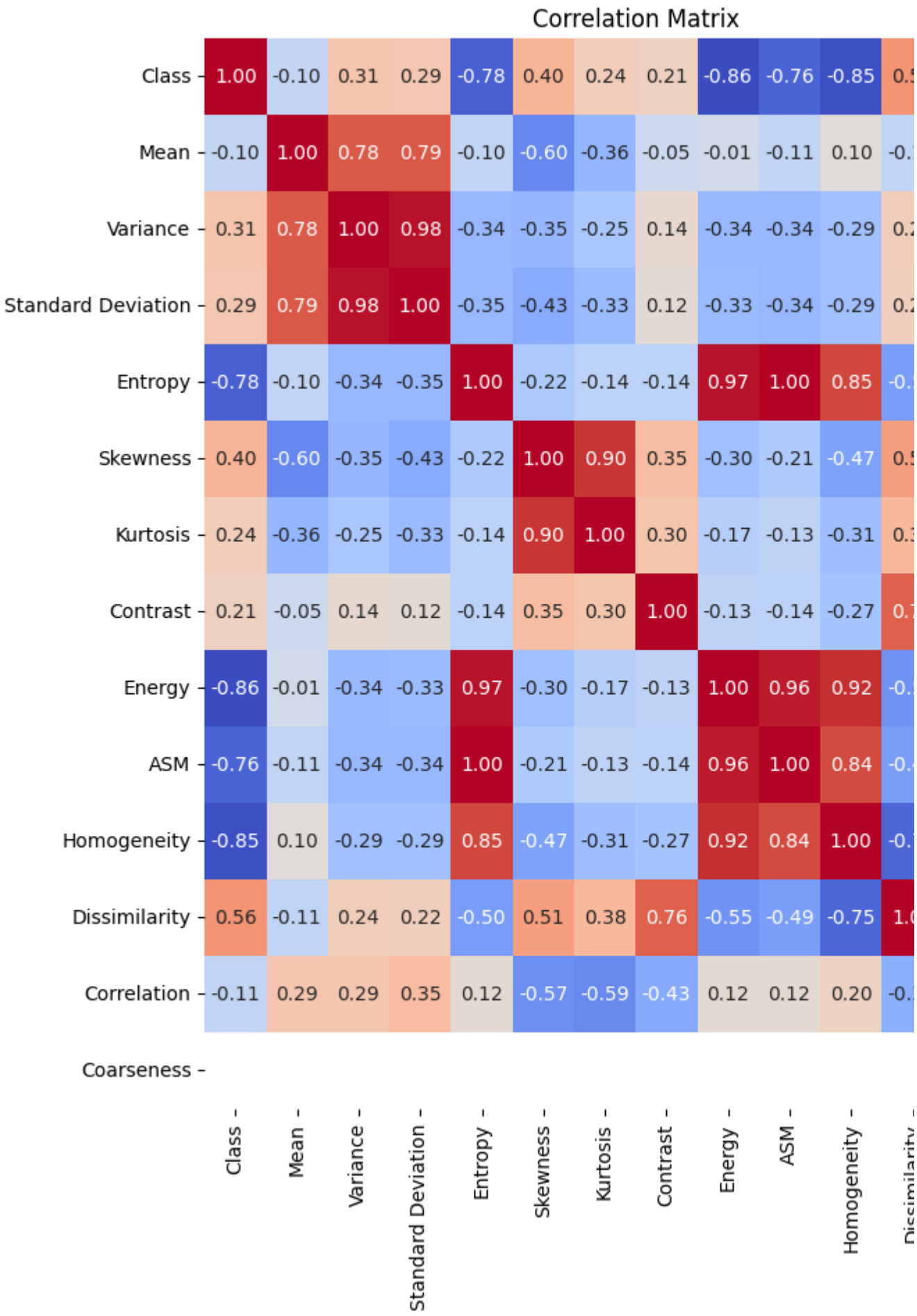
In [30…

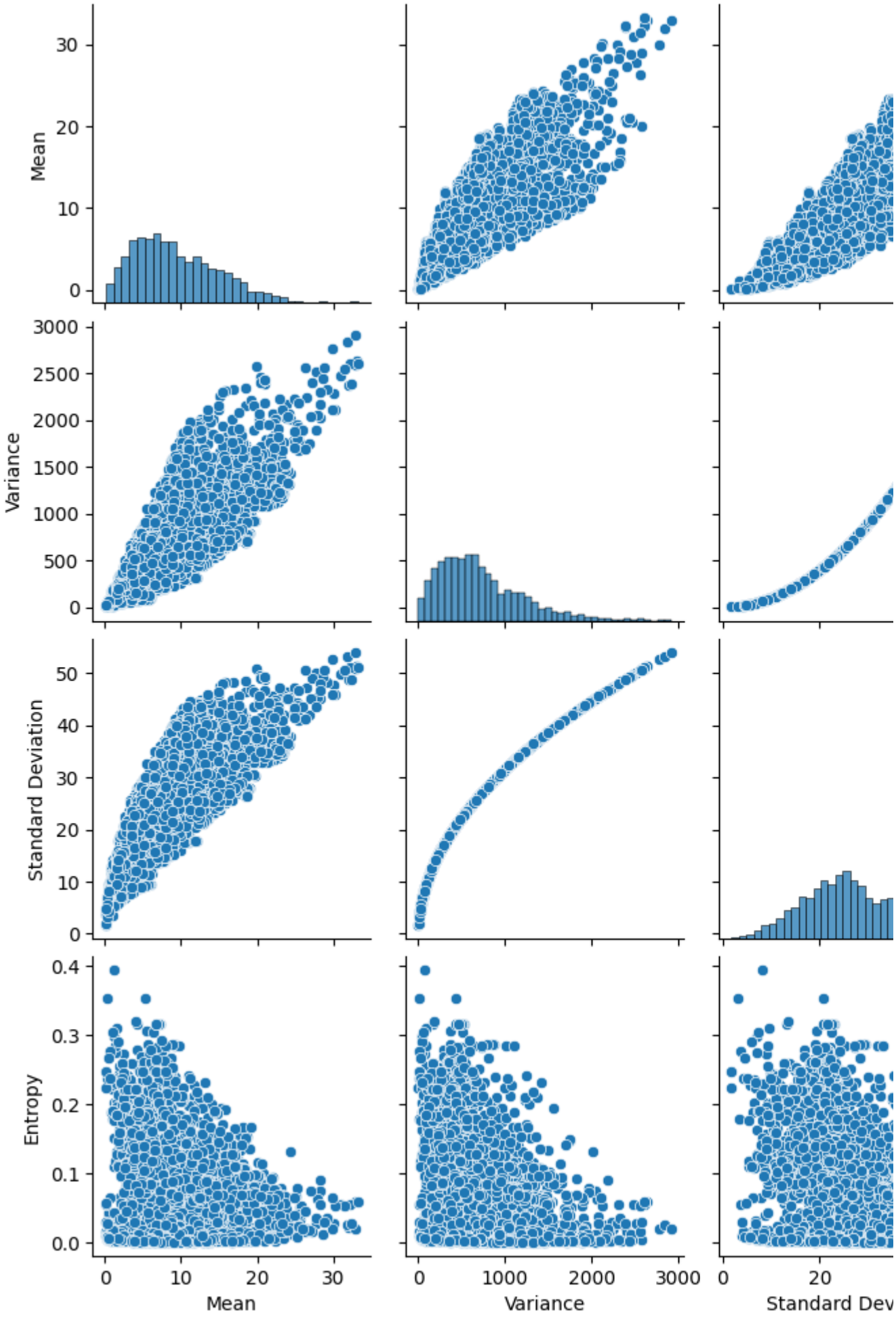
```python
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns

# EDA
data = pd.read_csv('/content/Brain Tumor.csv')


print(data.describe())


sns.countplot(x='Class', data=data)
plt.title('Distribution of Classes')
plt.show()

# corr m - remind yourself to remove this if it does not provide useful in
corr_matrix = data.corr()
plt.figure(figsize=(10, 10))
sns.heatmap(corr_matrix, annot=True, fmt=".2f", cmap='coolwarm')
plt.title('Correlation Matrix')
plt.show()



selected_features = ["Mean", "Variance", "Standard Deviation", "Entropy"]
sns.pairplot(data[selected_features])
plt.show()
```

```
              Class         Mean     Variance  Standard Deviation      Entropy  \
count  3762.000000  3762.000000  3762.000000         3762.000000  3762.000000
mean      0.447368     9.488890   711.101063           25.182271     0.073603
std       0.497288     5.728022   467.466896            8.773526     0.070269
min       0.000000     0.078659     3.145628            1.773592     0.000882
25%       0.000000     4.982395   363.225459           19.058475     0.006856
50%       0.000000     8.477531   622.580417           24.951560     0.066628
75%       1.000000    13.212723   966.954319           31.095889     0.113284
max       1.000000    33.239975  2910.581879           53.949809     0.394539

           Skewness     Kurtosis     Contrast       Energy          ASM  \
count  3762.000000  3762.000000  3762.000000  3762.000000  3762.000000
mean      4.102727    24.389071   127.961459     0.204705     0.058632
std       2.560940    56.434747   109.499601     0.129352     0.058300
min       1.886014     3.942402     3.194733     0.024731     0.000612
25%       2.620203     7.252852    72.125208     0.069617     0.004847
50%       3.422210    12.359088   106.737418     0.225496     0.050849
75%       4.651737    22.640304   161.059006     0.298901     0.089342
max      36.931294  1371.640060  3382.574163     0.589682     0.347725

       Homogeneity  Dissimilarity  Correlation     Coarseness
count  3762.000000    3762.000000  3762.000000   3.762000e+03
mean      0.479252       4.698498     0.955767  7.458341e-155
std       0.127929       1.850173     0.026157   0.000000e+00
min       0.105490       0.681121     0.549426  7.458341e-155
25%       0.364973       3.412363     0.947138  7.458341e-155
50%       0.512551       4.482404     0.961610  7.458341e-155
75%       0.575557       5.723821     0.971355  7.458341e-155
max       0.810921      27.827751     0.989972  7.458341e-155
```




```
<ipython-input-30-870efe3d9939>:17: FutureWarning: The default value of
numeric_only in DataFrame.corr is deprecated. In a future version, it will
default to False. Select only valid columns or specify the value of numeric_only
to silence this warning.
  corr_matrix = data.corr()
```


Correlation Matrix
Class
Mean
Variance
Standard Deviation
Entropy
Skewness
Kurtosis
Contrast
Energy
ASM
Homogeneity
Dissimilarity
Correlation
Coarseness
1.00 -0.10 0.31 0.29 -0.78 0.40 0.24 0.21 -0.86 -0.76 -0.85
-0.10 1.00 0.78 0.79 -0.10 -0.60 -0.36 -0.05 -0.01 -0.11 0.10
0.31 0.78 1.00 0.98 -0.34 -0.35 -0.25 0.14 -0.34 -0.34 -0.29
0.29 0.79 0.98 1.00 -0.35 -0.43 -0.33 0.12 -0.33 -0.34 -0.29
-0.78 -0.10 -0.34 -0.35 1.00 -0.22 -0.14 -0.14 0.97 1.00 0.85
0.40 -0.60 -0.35 -0.43 -0.22 1.00 0.90 0.35 -0.30 -0.21 -0.47
0.24 -0.36 -0.25 -0.33 -0.14 0.90 1.00 0.30 -0.17 -0.13 -0.31
0.21 -0.05 0.14 0.12 -0.14 0.35 0.30 1.00 -0.13 -0.14 -0.27
-0.86 -0.01 -0.34 -0.33 0.97 -0.30 -0.17 -0.13 1.00 0.96 0.92
-0.76 -0.11 -0.34 -0.34 1.00 -0.21 -0.13 -0.14 0.96 1.00 0.84
-0.85 0.10 -0.29 -0.29 0.85 -0.47 -0.31 -0.27 0.92 0.84 1.00
0.56 -0.11 0.24 0.22 -0.50 0.51 0.38 0.76 -0.55 -0.49 -0.75
-0.11 0.29 0.29 0.35 0.12 -0.57 -0.59 -0.43 0.12 0.12 0.20


Mean
Variance
Standard Deviation
Entropy
Mean
Variance
Standard Dev

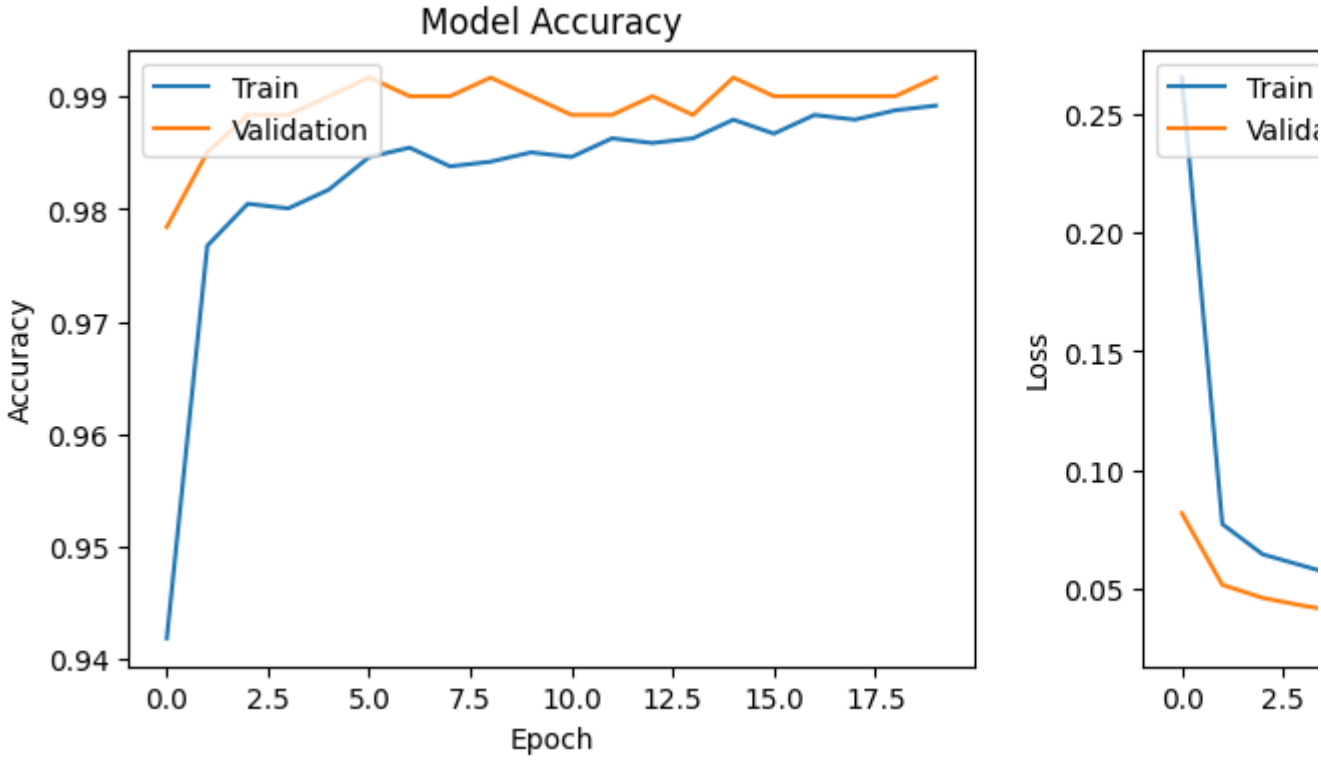
In […

```
#model 1

import pandas as pd
from sklearn.model_selection import train_test_split
from sklearn.preprocessing import StandardScaler
from sklearn.feature_selection import SelectKBest, f_classif
from keras.models import Sequential
from keras.layers import Dense
import matplotlib.pyplot as plt
import numpy as np

data = pd.read_csv('/content/Brain Tumor.csv')
data = data.replace([np.inf, -np.inf], np.nan)
data = data.fillna(data.mean())

X = data.drop(['Image', 'Class'], axis=1)
y = data['Class']

# Feature engineering
selector = SelectKBest(score_func=f_classif, k=10)
X_selected = selector.fit_transform(X, y)


selected_indices = selector.get_support(indices=True)


selected_columns = X.columns[selected_indices]

print("Selected Features:")
for column in selected_columns:
    print(column)


X_train, X_test, y_train, y_test = train_test_split(X_selected, y, test_size

# Normalize
scaler = StandardScaler()
X_train = scaler.fit_transform(X_train)
X_test = scaler.transform(X_test)


model = Sequential()
model.add(Dense(64, activation='relu', input_shape=(X_train.shape[1],)))
model.add(Dense(64, activation='relu'))
model.add(Dense(1, activation='sigmoid'))

model.compile(optimizer='adam', loss='binary_crossentropy', metrics=['accura


history = model.fit(X_train, y_train, epochs=20, validation_split=0.2)

_, train_acc = model.evaluate(X_train, y_train, verbose=0)
_, test_acc = model.evaluate(X_test, y_test, verbose=0)

print('Train: %.3f, Test: %.3f' % (train_acc, test_acc))

plt.figure(figsize=(12, 4))
plt.subplot(1, 2, 1)
plt.plot(history.history['accuracy'])
```

```
plt.plot(history.history['val_accuracy'])
plt.title('Model Accuracy')
plt.ylabel('Accuracy')
plt.xlabel('Epoch')
plt.legend(['Train', 'Validation'], loc='upper left')

plt.subplot(1, 2, 2)
plt.plot(history.history['loss'])
plt.plot(history.history['val_loss'])
plt.title('Model Loss')
plt.ylabel('Loss')
plt.xlabel('Epoch')
plt.legend(['Train', 'Validation'], loc='upper left')

plt.show()
```

```
<ipython-input-31-a00c492d20cc>:12: FutureWarning: The default value of
numeric_only in DataFrame.mean is deprecated. In a future version, it will
default to False. In addition, specifying 'numeric_only=None' is deprecated.
Select only valid columns or specify the value of numeric_only to silence this
warning.
  data = data.fillna(data.mean())
```

```
Selected Features:
Variance
Standard Deviation
Entropy
Skewness
Kurtosis
Contrast
Energy
ASM
Homogeneity
Dissimilarity
Epoch 1/20
76/76 [==============================] - 1s 7ms/step - loss: 0.2654 - accuracy:
0.9418 - val_loss: 0.0817 - val_accuracy: 0.9784
Epoch 2/20
76/76 [==============================] - 0s 5ms/step - loss: 0.0771 - accuracy:
0.9767 - val_loss: 0.0515 - val_accuracy: 0.9850
Epoch 3/20
76/76 [==============================] - 0s 5ms/step - loss: 0.0644 - accuracy:
0.9805 - val_loss: 0.0460 - val_accuracy: 0.9884
Epoch 4/20
76/76 [==============================] - 0s 5ms/step - loss: 0.0595 - accuracy:
0.9801 - val_loss: 0.0427 - val_accuracy: 0.9884
Epoch 5/20
76/76 [==============================] - 0s 5ms/step - loss: 0.0547 - accuracy:
0.9817 - val_loss: 0.0399 - val_accuracy: 0.9900
Epoch 6/20
76/76 [==============================] - 0s 6ms/step - loss: 0.0510 - accuracy:
0.9846 - val_loss: 0.0397 - val_accuracy: 0.9917
Epoch 7/20
76/76 [==============================] - 0s 5ms/step - loss: 0.0475 - accuracy:
0.9855 - val_loss: 0.0388 - val_accuracy: 0.9900
Epoch 8/20
76/76 [==============================] - 0s 5ms/step - loss: 0.0446 - accuracy:
0.9838 - val_loss: 0.0398 - val_accuracy: 0.9900
Epoch 9/20
76/76 [==============================] - 0s 5ms/step - loss: 0.0434 - accuracy:
0.9842 - val_loss: 0.0368 - val_accuracy: 0.9917
Epoch 10/20
76/76 [==============================] - 1s 17ms/step - loss: 0.0416 - accuracy:
0.9850 - val_loss: 0.0380 - val_accuracy: 0.9900
Epoch 11/20
76/76 [==============================] - 0s 6ms/step - loss: 0.0408 - accuracy:
0.9846 - val_loss: 0.0359 - val_accuracy: 0.9884
Epoch 12/20
76/76 [==============================] - 0s 3ms/step - loss: 0.0380 - accuracy:
0.9863 - val_loss: 0.0344 - val_accuracy: 0.9884
Epoch 13/20
76/76 [==============================] - 0s 4ms/step - loss: 0.0381 - accuracy:
0.9859 - val_loss: 0.0375 - val_accuracy: 0.9900
Epoch 14/20
76/76 [==============================] - 0s 3ms/step - loss: 0.0372 - accuracy:
0.9863 - val_loss: 0.0340 - val_accuracy: 0.9884
Epoch 15/20
76/76 [==============================] - 0s 4ms/step - loss: 0.0356 - accuracy:
0.9880 - val_loss: 0.0317 - val_accuracy: 0.9917
Epoch 16/20
76/76 [==============================] - 0s 4ms/step - loss: 0.0336 - accuracy:
0.9867 - val_loss: 0.0343 - val_accuracy: 0.9900
Epoch 17/20
76/76 [==============================] - 0s 3ms/step - loss: 0.0318 - accuracy:
```



In […
```
from sklearn.metrics import precision_score, recall_score, f1_score, roc_auc
```

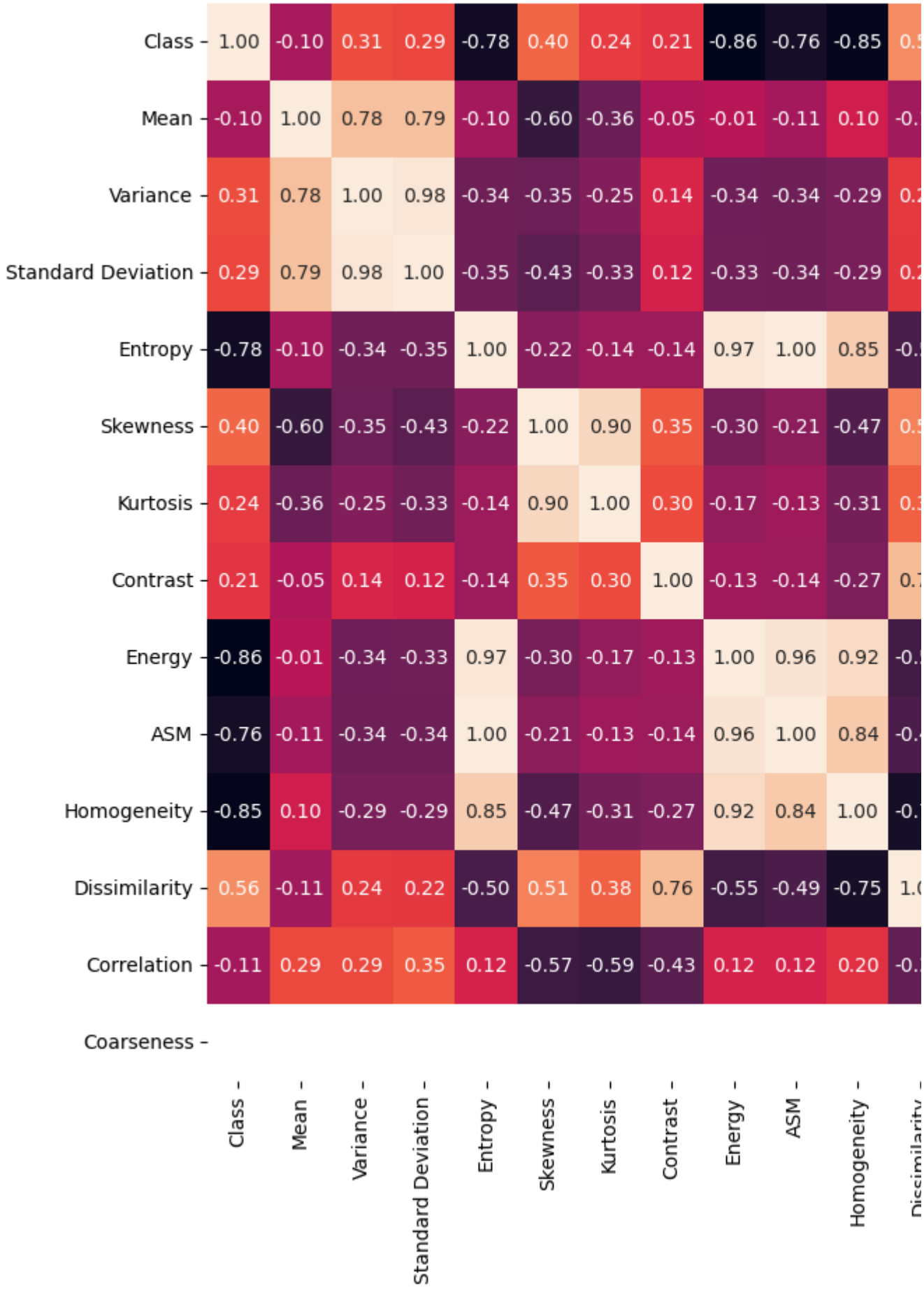
```
y_pred = model.predict(X_test)
y_pred = [1 if p > 0.5 else 0 for p in y_pred]

#performance metrics
precision = precision_score(y_test, y_pred)
recall = recall_score(y_test, y_pred)
f1 = f1_score(y_test, y_pred)
roc_auc = roc_auc_score(y_test, y_pred)

print('Precision: %.3f, Recall: %.3f, F1 Score: %.3f, ROC AUC: %.3f' % (prec
```

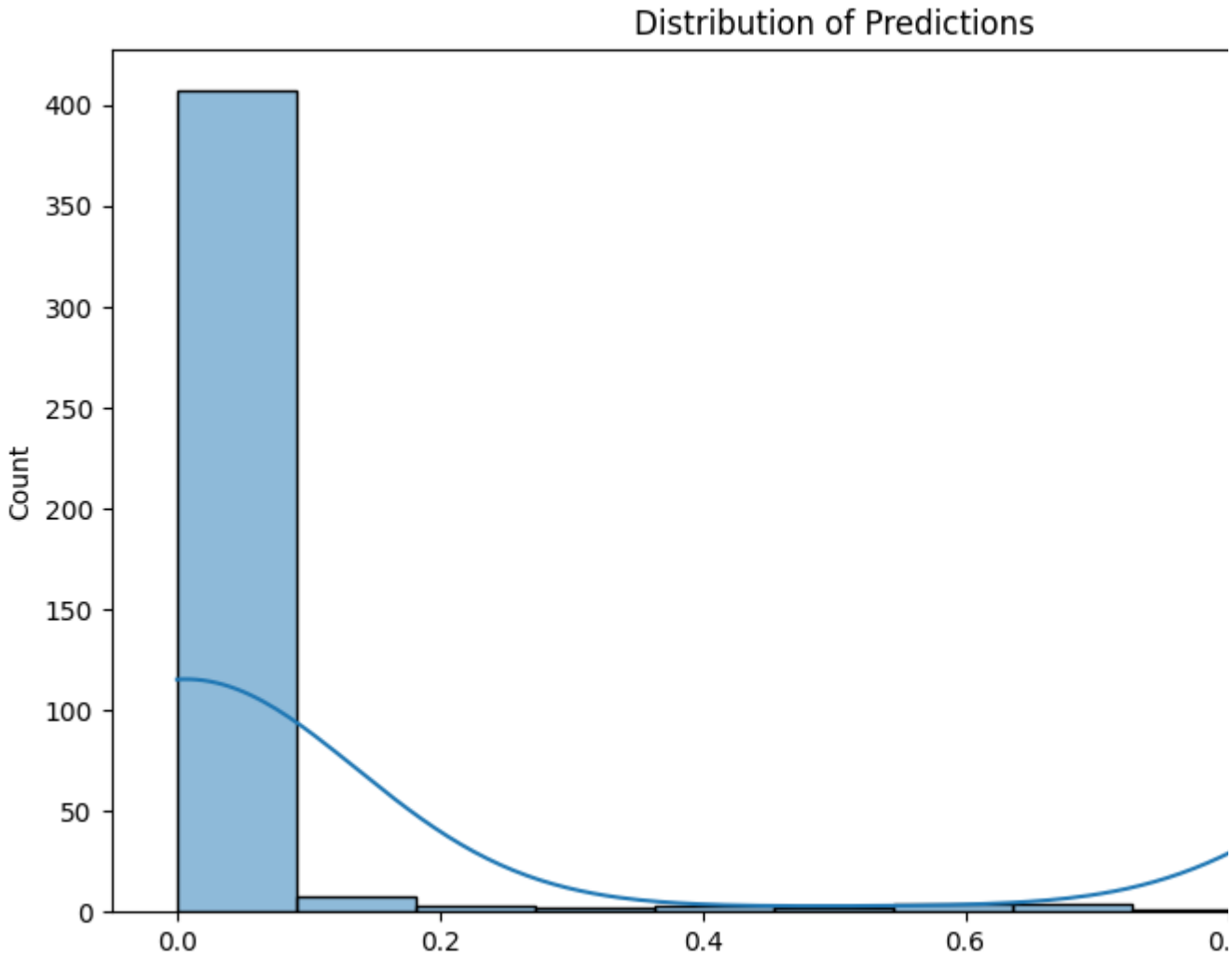
```
24/24 [==============================] - 0s 1ms/step
Precision: 0.991, Recall: 0.973, F1 Score: 0.982, ROC AUC: 0.983
```

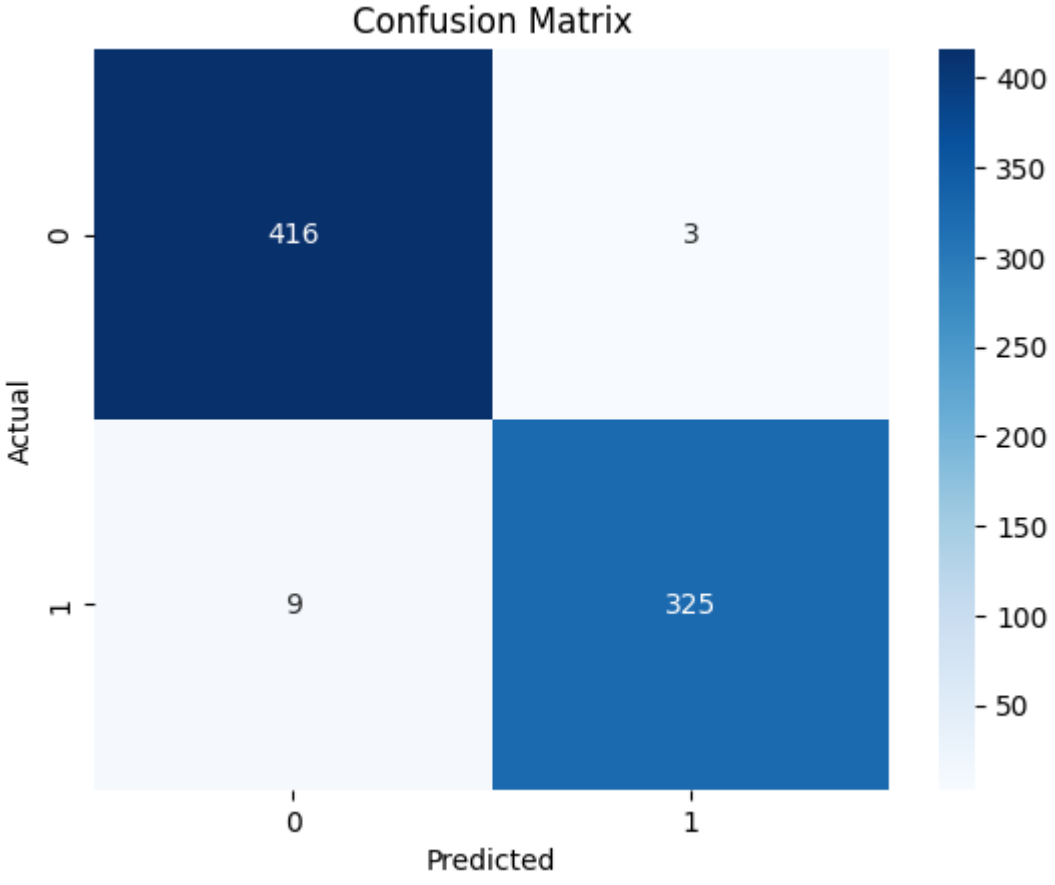
In [33]:
```
import matplotlib.pyplot as plt
import seaborn as sns
from sklearn.metrics import confusion_matrix, roc_curve, roc_auc_score


y_pred = (model.predict(X_test) > 0.5).astype("int32")
y_pred_proba = model.predict(X_test)

plt.figure(figsize=(10,10))
sns.heatmap(data.corr(), annot=True, fmt=".2f")
plt.show()


plt.figure(figsize=(10,6))
plt.title('Distribution of Predictions')
sns.histplot(y_pred_proba, kde=True)
plt.show()


cf_matrix = confusion_matrix(y_test, y_pred)
sns.heatmap(cf_matrix, annot=True, fmt='d', cmap='Blues')
plt.xlabel('Predicted')
plt.ylabel('Actual')
plt.title('Confusion Matrix')
plt.show()


fpr, tpr, _ = roc_curve(y_test, y_pred_proba)
auc = roc_auc_score(y_test, y_pred_proba)
plt.plot(fpr,tpr,label="AUC="+str(auc))
plt.legend(loc=4)
plt.title('Receiver Operating Characteristic Curve')
plt.show()
```

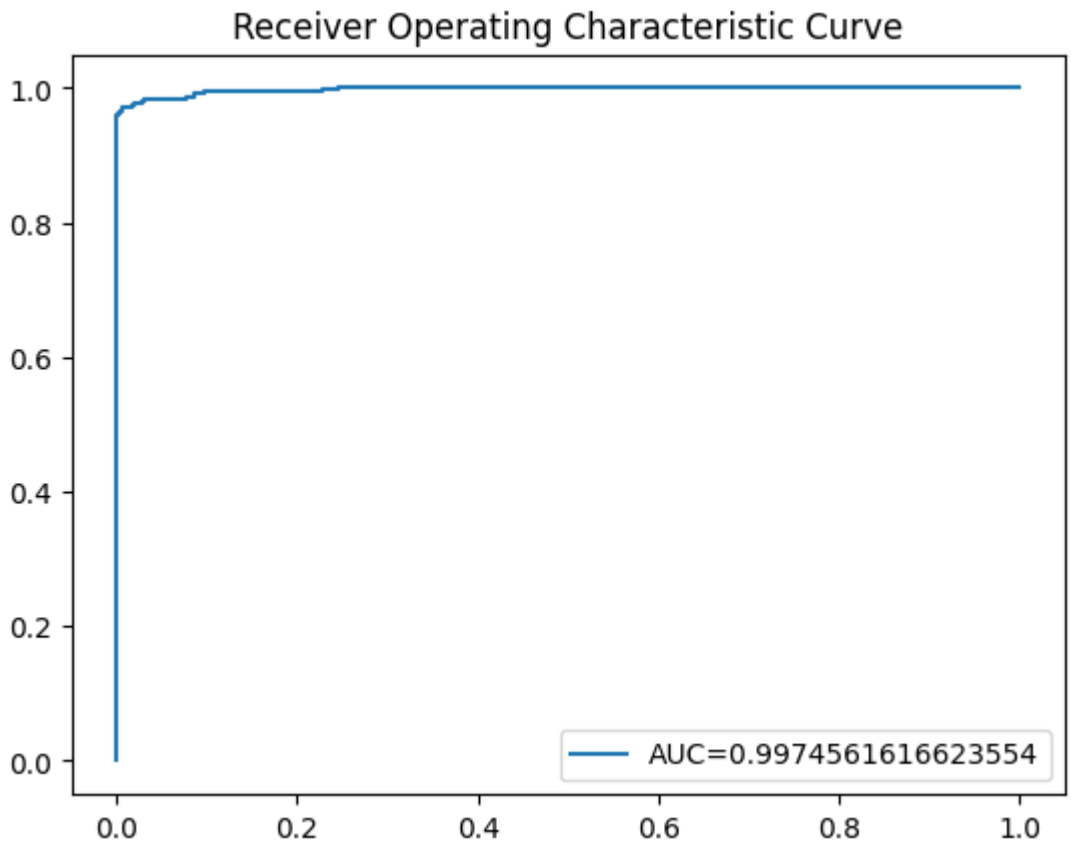
```
24/24 [==============================] - 0s 1ms/step
24/24 [==============================] - 0s 2ms/step
```

```
<ipython-input-33-39b6281ba315>:10: FutureWarning: The default value of
numeric_only in DataFrame.corr is deprecated. In a future version, it will
default to False. Select only valid columns or specify the value of numeric_only
to silence this warning.
  sns.heatmap(data.corr(), annot=True, fmt=".2f")
```


Class 1.00 -0.10 0.31 0.29 -0.78 0.40 0.24 0.21 -0.86 -0.76 -0.85
Mean -0.10 1.00 0.78 0.79 -0.10 -0.60 -0.36 -0.05 -0.01 -0.11 0.10
Variance 0.31 0.78 1.00 0.98 -0.34 -0.35 -0.25 0.14 -0.34 -0.34 -0.29
Standard Deviation 0.29 0.79 0.98 1.00 -0.35 -0.43 -0.33 0.12 -0.33 -0.34 -0.29
Entropy -0.78 -0.10 -0.34 -0.35 1.00 -0.22 -0.14 -0.14 0.97 1.00 0.85
Skewness 0.40 -0.60 -0.35 -0.43 -0.22 1.00 0.90 0.35 -0.30 -0.21 -0.47
Kurtosis 0.24 -0.36 -0.25 -0.33 -0.14 0.90 1.00 0.30 -0.17 -0.13 -0.31
Contrast 0.21 -0.05 0.14 0.12 -0.14 0.35 0.30 1.00 -0.13 -0.14 -0.27
Energy -0.86 -0.01 -0.34 -0.33 0.97 -0.30 -0.17 -0.13 1.00 0.96 0.92
ASM -0.76 -0.11 -0.34 -0.34 1.00 -0.21 -0.13 -0.14 0.96 1.00 0.84
Homogeneity -0.85 0.10 -0.29 -0.29 0.85 -0.47 -0.31 -0.27 0.92 0.84 1.00
Dissimilarity 0.56 -0.11 0.24 0.22 -0.50 0.51 0.38 0.76 -0.55 -0.49 -0.75
Correlation -0.11 0.29 0.29 0.35 0.12 -0.57 -0.59 -0.43 0.12 0.12 0.20
Coarseness
Class
Mean
Variance
Standard Deviation
Entropy
Skewness
Kurtosis
Contrast
Energy
ASM
Homogeneity


Distribution of Predictions
Count
400
350
300
250
200
150
100
50
0
0.0
0.2
0.4
0.6


Confusion Matrix
Actual
Predicted
0
1
416
3
9
325
400
350
300
250
200
150
100
50


Receiver Operating Characteristic Curve
1.0
0.8
0.6
0.4
0.2
0.0
0.0
0.2
0.4
0.6
0.8
1.0
AUC=0.9974561616623554

In [3…

```
#Image Classificaiton Model #Model2

import tensorflow as tf
from tensorflow.keras.preprocessing.image import ImageDataGenerator
from tensorflow.keras.applications import MobileNetV2
from tensorflow.keras.layers import Dense, GlobalAveragePooling2D
from tensorflow.keras.models import Model
import os


from google.colab import drive
drive.mount('/content/drive')


dataset_directory = '/content/drive/MyDrive/brain_tumor_dataset'

image_size = (330, 330)

datagen = ImageDataGenerator(
    rescale=1./255,
    rotation_range=30,
    width_shift_range=0.2,
    height_shift_range=0.2,
    shear_range=0.2,
    zoom_range=0.2,
    horizontal_flip=True,
    validation_split=0.2
)

data_generator = datagen.flow_from_directory(
    dataset_directory,
    target_size=image_size,
    batch_size=32,
    class_mode='binary',
    subset='training'
)

validation_generator = datagen.flow_from_directory(
    dataset_directory,
    target_size=image_size,
    batch_size=32,
    class_mode='binary',
    subset='validation'
)

base_model = MobileNetV2(
    include_top=False,
    weights='imagenet',
    input_shape=(image_size[0], image_size[1], 3)
)

base_model.trainable = False

x = base_model.output
x = GlobalAveragePooling2D()(x)
x = Dense(64, activation='relu')(x)
predictions = Dense(1, activation='sigmoid')(x)

model = Model(inputs=base_model.input, outputs=predictions)
```

```
model.compile(optimizer='adam', loss='binary_crossentropy', metrics=['accuracy'])

history = model.fit(
    data_generator,
    steps_per_epoch=data_generator.samples // data_generator.batch_size,
    validation_data=validation_generator,
    validation_steps=validation_generator.samples // validation_generator.batch_siz
    epochs=10
)
```

```
Drive already mounted at /content/drive; to attempt to forcibly remount, call
drive.mount("/content/drive", force_remount=True).
Found 203 images belonging to 2 classes.
Found 50 images belonging to 2 classes.
WARNING:tensorflow:`input_shape` is undefined or non-square, or `rows` is not in
[96, 128, 160, 192, 224]. Weights for input shape (224, 224) will be loaded as
the default.
Epoch 1/10
6/6 [==============================] - 47s 7s/step - loss: 0.7217 - accuracy:
0.5833 - val_loss: 0.6014 - val_accuracy: 0.7188
Epoch 2/10
6/6 [==============================] - 33s 5s/step - loss: 0.5737 - accuracy:
0.7310 - val_loss: 0.5025 - val_accuracy: 0.6562
Epoch 3/10
6/6 [==============================] - 31s 5s/step - loss: 0.5325 - accuracy:
0.7310 - val_loss: 0.4072 - val_accuracy: 0.8438
Epoch 4/10
6/6 [==============================] - 33s 6s/step - loss: 0.4869 - accuracy:
0.7953 - val_loss: 0.3066 - val_accuracy: 0.8750
Epoch 5/10
6/6 [==============================] - 36s 6s/step - loss: 0.4452 - accuracy:
0.7895 - val_loss: 0.2711 - val_accuracy: 0.9062
Epoch 6/10
6/6 [==============================] - 37s 7s/step - loss: 0.4377 - accuracy:
0.8070 - val_loss: 0.2085 - val_accuracy: 1.0000
Epoch 7/10
6/6 [==============================] - 38s 6s/step - loss: 0.3843 - accuracy:
0.8480 - val_loss: 0.2709 - val_accuracy: 0.9375
Epoch 8/10
6/6 [==============================] - 30s 5s/step - loss: 0.3414 - accuracy:
0.8655 - val_loss: 0.2850 - val_accuracy: 0.9062
Epoch 9/10
6/6 [==============================] - 32s 5s/step - loss: 0.3518 - accuracy:
0.8538 - val_loss: 0.1738 - val_accuracy: 0.9375
Epoch 10/10
6/6 [==============================] - 32s 5s/step - loss: 0.3535 - accuracy:
0.8772 - val_loss: 0.2736 - val_accuracy: 0.8750
```

In [35…

```python
#testing accuracy on validation set

import pandas as pd


loss, accuracy = model.evaluate(validation_generator)
print(f'Loss: {loss}, Accuracy: {accuracy}')


predictions = model.predict(validation_generator)


binary_predictions = [1 if p > 0.5 else 0 for p in predictions.flatten()]


df_predictions = pd.DataFrame(binary_predictions, columns=['Predictions'])


print(df_predictions)
```

```
2/2 [==============================] - 8s 3s/step - loss: 0.2583 - accuracy:
0.9200
Loss: 0.2582961618900299, Accuracy: 0.9200000166893005
2/2 [==============================] - 11s 1s/step
    Predictions
0             1
1             0
2             1
3             0
4             0
5             1
6             1
7             0
8             0
9             0
10            0
11            0
12            0
13            0
14            1
15            1
16            1
17            0
18            0
19            0
20            1
21            1
22            0
23            0
24            1
25            0
26            1
27            1
28            1
29            1
30            0
31            1
32            1
33            1
34            1
35            1
36            0
37            1
38            0
39            1
40            1
41            1
42            1
43            1
44            0
45            0
46            1
47            1
48            0
49            1
```

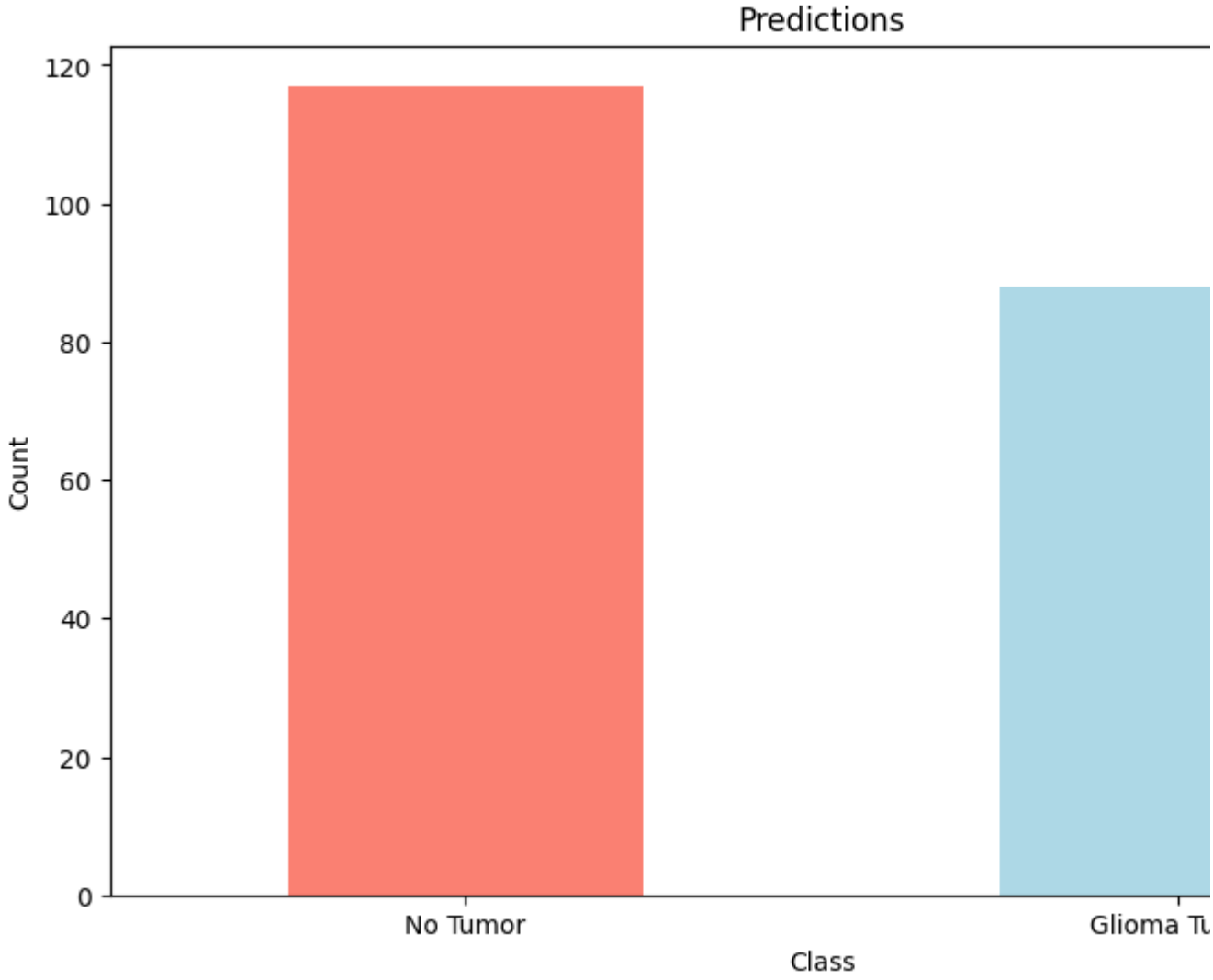
In [3…
```
#prediction on unseen data

import os
from tensorflow.keras.preprocessing.image import ImageDataGenerator
import pandas as pd


unseen_dataset_directory = '/content/drive/MyDrive/unseen3'

unseen_datagen = ImageDataGenerator(rescale=1./255)


unseen_data_generator = unseen_datagen.flow_from_directory(
    unseen_dataset_directory,
    target_size=image_size,
    batch_size=32,
    class_mode=None,
    shuffle=False
)
file_names = unseen_data_generator.filenames

predictions = model.predict(unseen_data_generator)


binary_predictions = [1 if p > 0.5 else 0 for p in predictions.flatten()]


df_predictions = pd.DataFrame({'Image': file_names, 'Prediction': binary_pr


#print(df_predictions)
```

```
Found 205 images belonging to 2 classes.
7/7 [==============================] - 25s 3s/step
```

In […
```
df_predictions['TrueLabel'] = df_predictions['Image'].apply(lambda x: 1 if '


correct_predictions = (df_predictions['TrueLabel'] == df_predictions['Predic


accuracy = correct_predictions / len(df_predictions)

print(f'Accuracy: {accuracy * 100}%')
```

```
Accuracy: 82.92682926829268%
```

In [3…
```
import matplotlib.pyplot as plt
from sklearn.metrics import roc_curve, auc


plt.figure(figsize=(10, 6))


df_predictions['Prediction'].value_counts().plot(kind='bar', color=['salmon
plt.title('Predictions')
plt.xlabel('Class')
plt.ylabel('Count')
plt.xticks([0, 1], ['No Tumor', 'Glioma Tumor'], rotation=0)
plt.show()
```


Predictions
120
100
80
60
40
20
0
Count
No Tumor
Glioma Tu
Class